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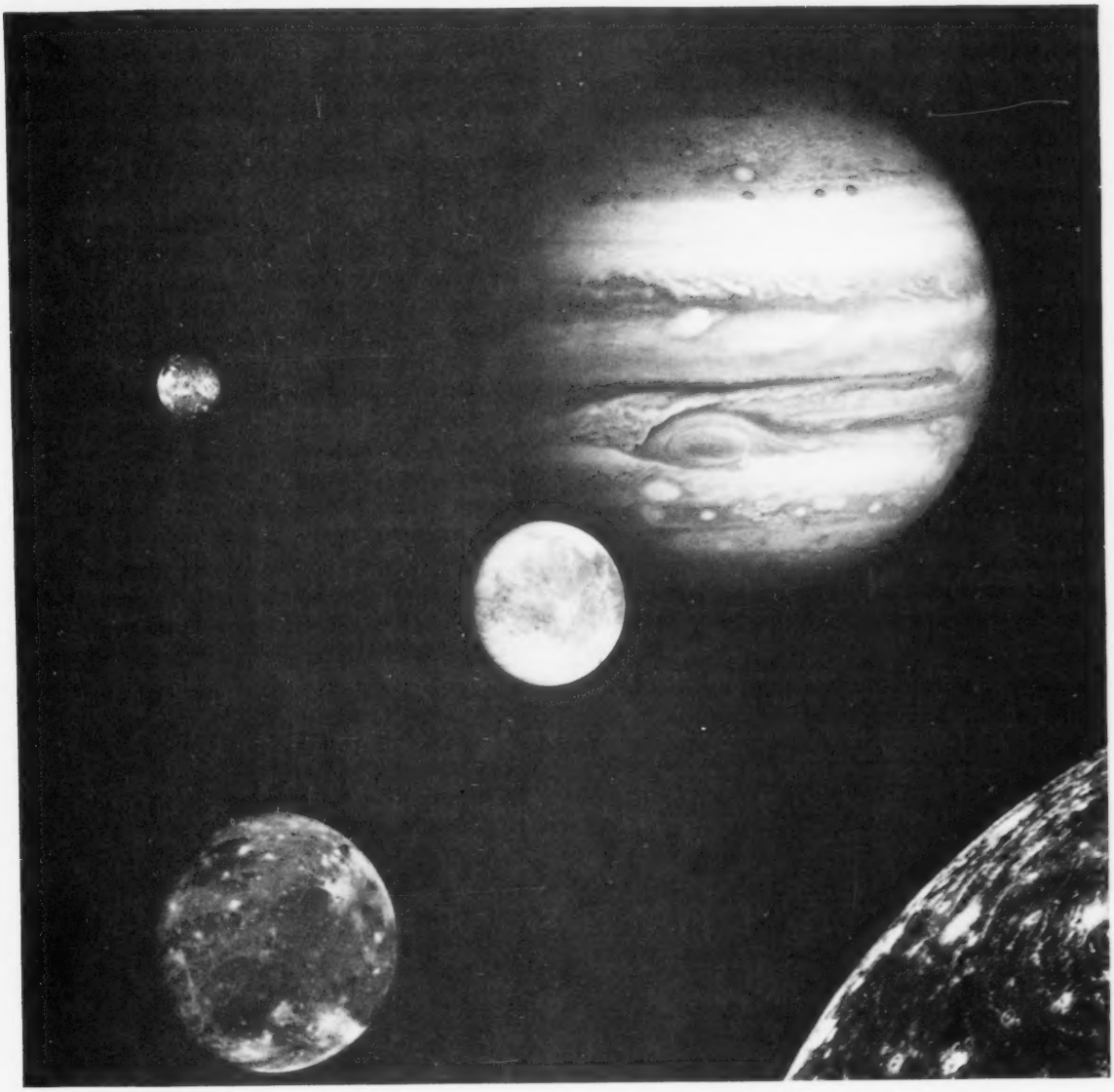

Cover

Jupiter and Satellites—The four planet-sized moons surrounding Jupiter, called the Galilean satellites, were photographed last spring by Voyager 1 and assembled into this collage. Not to scale, but in their relative positions are: Io (upper left) is nearest to Jupiter; Europa (center); Ganymede and Callisto (lower right). Nine other much smaller satellites encircle Jupiter, one inside Io's orbit and the other millions of miles from the planet. Not visible is Jupiter's faint ring of particles, seen for the first time by Voyager 1.

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The Skylab Spectacular

As it began, so it ended—with style, heavy drama, and great suspense. That was Skylab—in distress from the beginning, in and out of trouble, but somehow managing to perform its assignments successfully, right up to its spectacular finish.

The 70-metric-ton Skylab space station ended more than six years of circling the Earth on July 11 as it flashed through the atmosphere and disintegrated in a shower of fireworks over the Indian Ocean. In its final few minutes of life, the spacecraft overshot its predicted target in the ocean and scattered debris across a flat, sparsely settled region of Australia.

The last official decay prediction issued by the North American Air Defense Command Space Defense Center said that entry occurred at 12:37 p.m., EDT, on July 11, give or take two minutes.

Coordinates given by NORAD for the point where the heaviest debris lost its forward velocity, at an altitude of 10 kilometers, were 31.8 degrees south latitude and 124.4 degrees east longitude. That was over the small Australian community of Kalgoorlie in Western Australia.

Soon after launch on May 14, 1973, problems with the unmanned Saturn workshop had to be corrected by the first crew of astronauts sent up on May 25.

In all, three crews of astronauts were to call Skylab home for varying periods of times.

The crews and their missions were: Pete Conrad, Joe Kerwin and Paul Weitz, May 25 to June 22, 1973, 28 days, 50 minutes; Al Bean, Owen Garriott and Jack Lousma, July 28 to Sept. 25, 1973, 59 days, 11 hours and 9 minutes; and Gerald Carr, Ed Gibson and Bill Pogue, Nov. 16, 1973 to Feb. 8, 1974, 84 days, 1 hour and 17 minutes. The final mission held the record of longest manned mission until surpassed by a Soviet crew of cosmonauts in 1978.

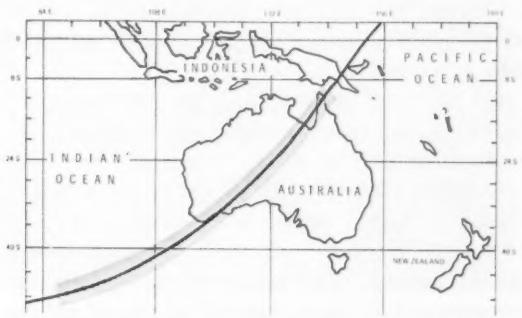
Nearly 300 scientific and technical investigations were performed during one or more of the three manned missions and sometimes even for unattended operation between missions. These included medical experiments on man's adaptation to zero gravity; intensive studies of the Sun, with a major scientific accomplishment in the monitoring of a solar flare; and detailed Earth resources experiments.

During the three days that made up the Skylab deathwatch, the activities taking place at the NASA headquarters newsroom could only be described as incredible. The NASA staff went on 24-hour duty beginning Sunday, July 8, with support from the Johnson Space Center, the Marshall Space Flight Center, and the Kennedy Space Center. Crowds of news people from all over the world filled all available visitor space, some of them maintaining overnight vigils on the Skylab beat. Telephones rang incessantly, with serious, funny, sometimes frightened people calling from many U.S. locations and foreign areas.

In the headquarters auditorium, which was the designated press headquarters, the scene was one of controlled confusion. All major television networks staffed the event with many reporters and photographers. Radio reporters and journalists came from newspapers and magazines worldwide, wire service writers, and helpers all had to be accommodated, along with cameras, TV monitors, telephones, walkie-talkies, typewriters, miles of electrical cables, and other equipment. Banks of public telephones were installed. Observers said that it was perhaps the biggest concentration of news media representatives even seen at headquarters.

The official Skylab operations center, staffed by about 20 people, opened on Tuesday morning, July 10, receiving periodic reports from NORAD in Colorado and the Johnson center. Representatives were present from the White House, the Federal Preparedness Agency, and the Departments of State, Justice and Defense. At the beginning, bulletins were issued every six hours, then every hour toward the end. Updated maps showing orbital paths were issued along with bulletins.

In the aftermath of the Skylab extravaganza, inquiries continued to pour into headquarters. So many people reported from points all over the country that they were in possession of pieces of Skylab that finally, a week afterward, NASA had to announce that it was no longer accepting any such samples, inasmuch as they were obviously not pieces of Skylab.



The Final "Footprint"—The dotted strip is where Skylab debris was presumed to have fallen to Earth, according to NASA estimates. Pieces were recovered from areas of Australia along the path.

Voyager 2 Looks Closely at Jupiter

Only four months after Voyager 1's startling discoveries about Jupiter, its major satellites and the complex Jovian environment, a twin NASA spacecraft, Voyager 2, homed in for a follow-up close encounter with the giant planet July 9. Voyager 1 began a seven-month Jupiter surveillance on Jan. 6, ending its encounter activities on April 13. Voyager 2 opened its observatory phase on April 25 and will monitor the Jovian system until Aug. 28.

Both spacecraft are continuing on to Saturn, where Voyager 2 may be retargeted toward Uranus. The two-spacecraft expedition could span a decade and produce a wealth of new information on as many as 15 major bodies of the solar system.

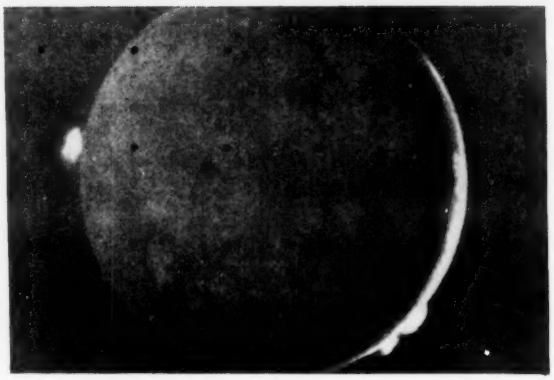
During its surprise-packed excursion through the Jovian system, Voyager 1 discovered a wispy ring of particles around Jupiter, bolts of lightning and immense auroras in the planet's violently churning atmosphere and towering volcanic eruptions on the satellite Io. More than 18,000 pictures of Jupiter, the Galilean satellites—Io, Europa, Ganymede, Callisto and tiny Amalthea—were obtained with the two-camera imaging system aboard Voyager 1 during the 98-day observation period.

The science sequences aboard Voyager 2, partially modified by the findings of Voyager 1, were programmed for nearly 15,000 pictures. At the time of closest encounter by Voyager 2, Jupiter will be 931,360,333 kilometers from Earth.

Scientists on the Voyager experiment teams found the various bodies in the Jovian system explored by Voyager 1 do not closely resemble either the planets nearer the Sun or one another. The wide range of unexpected findings, they determined, is because of the real differences between the outer and inner systems and the lack of prior knowledge. The latter is partly because of the great distance separating Earth and Jupiter.

Voyager 2 was launched Aug. 20, 1977, from Cape Canaveral aboard a Titan-Centaur rocket combination. On Sept. 5, 1977, Voyager 1 was boosted into a faster, shorter trajectory and moved ahead of Voyager 2 before the end of the year.

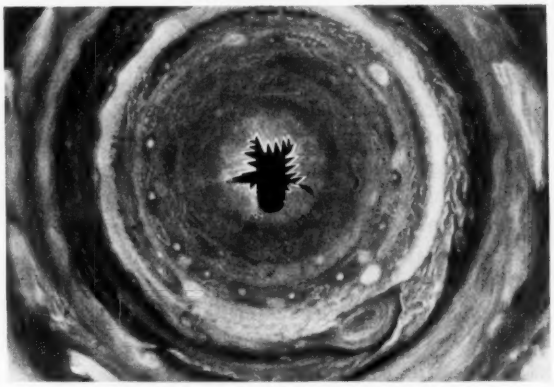
At Saturn encounter, the time-lag between the two Voyagers will be about nine months. Using Jupiter's enormous gravity, the trajectories are curved and the Voyagers accelerated for the Saturn leg of the mission. Voyager 1 will arrive at Saturn in November 1980 and Voyager 2 in August 1981. An option exists for controllers to target the Voyager 2 trajectory past Saturn for a January 1986 encounter with Uranus.



Three volcanic eruption plumes are visible on Io, in photo taken from 1.2 million kilometers.

After completing their planetary missions, both spacecraft will search for the outer limit of the solar wind, that boundary somewhere in our part of the Milky Way where the influence of the Sun gives way to the other stars of the galaxy.

Each Voyager uses 10 instruments and the spacecraft radio system to study the planets, their principal satellites, rings of the planets, the magnetic and radiation regions surrounding the planets, and the interplanetary medium. The Voyagers are carrying telescope-equipped slow-scan TV cameras, cosmic ray detectors, infrared spectrometer-radiometers, low-energy charged-particle detectors, magnetometers, photopolarimeters, planetary radio astronomy receivers, plasma detectors, plasma wave instruments and ultraviolet spectrometers. A total of 106 scientists make up the Voyager science experiment teams.



Two merged photos provide views of the northern and southern hemispheres of Jupiter.

The television investigation, probably the most interesting to most people because of the universal appeal of the visual image, resulted in some 50,000 pictures of Jupiter, Saturn, the rings of the planets, 11 of their moons and black space near the planets, in a search for new Jovian and Saturnian satellites. Jupiter's thin ring was discovered in one of the Voyager 1 black space pictures. Uranus, its recently discovered ring system, and one or more moons, also may become targets for the Voyager 2 cameras.

The other Voyager instruments will study the planetary and satellite atmospheres and ionospheres; the magnetospheres of Jupiter and Saturn and the relationships between those regions and the solar wind that streams from the Sun through interplanetary space; and radio signals from Jupiter which, after the Sun, emits the strongest radio noise in our sky. Other objectives include all-sky surveys of interplanetary space and the measurement of cosmic rays that invade the solar system from other regions of the galaxy.

Measurements of Voyager's radio communications waves will provide information on the gravitational fields and atmospheres of the planets and their satellites, the rings of Saturn, and the solar corona.

Jupiter and Saturn are by far the largest planets and together hold in their regimes more than two-thirds of all the moons in the solar system. Jupiter's diameter is 11 times that of Earth and contains more matter than all of the other planets and moons combined. With 13 known moons, four of them the size of small planets, Jupiter is a kind of miniature solar system. Saturn has 10 satellites and a spectacular ring system which appears to be made up of tiny pieces of ice and snow.

Until recently our knowledge of Jupiter and Saturn was rudimentary. Ground-based studies by optical, infrared and radio astronomy have defined the most basic properties of Jupiter and Saturn and their satellites and hinted at the unique scientific potential of these systems. Even less is known about Uranus and its environs.

In 1973 and 1974, Pioneer 10 and Pioneer 11 made reconnaissance flights to Jupiter. As the spacecraft sped past, instruments began to reveal the complexity of its atmosphere and the extent and strength of the Jovian magnetosphere. (Both spacecraft are still operating. Pioneer 11 will fly close by Saturn in September 1979.) Building on the Pioneer experience, Voyager is the next step in the exploration of the Jovian and Saturnian systems.

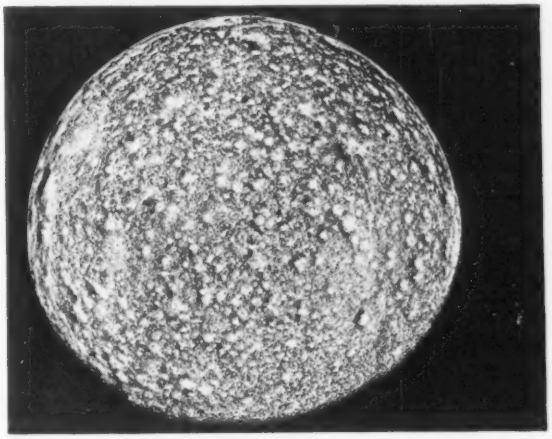
Voyager 2 began its observatory phase on April 25 by studying large-scale atmospheric processes on Jupiter and phenomena associated with the relationship between Jupiter's magnetosphere and the large inner moons. Taken as far away as 56 million km, the first Jupiter pictures by Voyager 2 exceeded the best resolution available with Earth telescopes.

Just as Voyager 1 observations during the approach to Jupiter in January showed dramatic broad-scale changes in features observed by the Pioneer 11 four years earlier, Voyager 2 has recorded visible differences in the huge Jovian features in much less time.

Voyager 2 made its closest approach to the planet on July 9 at a distance of about 650,000 km from the visible cloud tops. Activity reached a peak during the "near encounter" phase a 40-hour period surrounding closest approach. (In March 1979, the trajectory of Voyager 1 curved past the planet to a point just 278,000 km above the cloudtops.) The greater flyby distance for Voyager 2 results in less radiation exposure and a slower flight to Saturn.

The distance between Jupiter and Earth varies greatly in the four months separating the two encounters. Voyager 1 was about 250 million km closer to Earth at the time of its Jupiter rendezvous on March 5, because of the relative positions of the planets in their orbits around the Sun. By July 9, Earth will have traveled a distance equivalent to a third of its entire orbit around the Sun.

The trajectory for each spacecraft is unique and was designed for specific observations at both Jupiter and Saturn.



Impact crater distribution is very uniform across Callisto as seen in photos taken from a range of 390,000 kilometers.

The first spacecraft flew past Jupiter just south of the equator, while Voyager 2 made its Jupiter pass deep in the southern hemisphere.

Some of the Voyager 2 close encounter highlights include:

- The first high-resolution pictures of Europa. Voyager 1 showed Europa to be laced with huge intersecting linear features, even from a range of nearly 2,000,000 km. Voyager 2 improves upon the resolution of the March photos of Europa by about a factor of ten.
- Further examination of the thin ring of particles Voyager 1 found circling Jupiter. Voyager 2 crossed the equatorial plane twice—on July 8 and again on July 10. A color picture of the ring was obtained.
- An Io "volcano watch." The discovery of active vulcanism on the Jovian moon Io by Voyager 1 prompted planning for intensive Io imaging operations shortly after closest approach to Jupiter on July 9. Although the trajectory takes the spacecraft to a far greater Io encounter distance (1,130,000 km) than the March encounter (less than 20,000 km), a time-lapse imaging sequence will be executed to provide a possible history of erupting volcanos on the satellite.

The Voyager 2 trajectory also carries the spacecraft behind Jupiter, relative to Earth and the Sun. As Earth disappeared behind Jupiter, then emerged after two hours of occultation, the changes in the signal characteristics of the spacecraft radio link with Earth gave information about the vertical structure of the atmosphere, ionosphere and clouds. As the Sun was occulted by Jupiter, the ultraviolet spectrometer observed the Sun as it moved behind the limb of the planet thus showing similar scattering effects on sunlight as it penetrated the atmosphere. The 1¾-hour Earth occultation experiment took place July 10.

The southern hemisphere of Jupiter with Io silhouetted against the planet.

NASA's Office of Space Science has assigned project management and operation of the Voyager missions to the Jet Propulsion Laboratory which is managed for NASA by the California Institute of Technology. JPL designed, assembled and tested the spacecraft, and conducts tracking, communications and mission operations. The laboratory operates the Deep Space Network for NASA's Office of Tracking and Data Systems.

NASA program manager is Rodney A. Mills. JPL project manager is Raymond L. Heacock. Dr. Milton A. Mitz is NASA program scientist. Dr. Edward C. Stone of Caltech is project scientist.

Estimated cost of the Voyager project, exclusive of launch vehicles, tracking and data acquisition and flight support activities, is $343 million.

Solar-Powered Air Conditioner Tested

A new and efficient solar-powered air-conditioning system has been developed for homes and tested under the Department of Energy's solar heating and cooling development program. The Marshall Space Flight Center manages the program.

Under a Marshall center contract, the innovative system was developed by Lennox Industries, of Dallas, Texas, in cooperation with the Barber Nichols Engineering Co., of Denver, Colo., and Honeywell, Inc.

The air-conditioning unit uses an engine with a very small turbine, powered by solar-heated fluid, to drive the compressor of a conventional air-conditioning system. It has a cooling capacity of 2¾ metric tons (36,000 B.T.U. per hour), sufficient to cool the average American home.

A possible side benefit of the system is its ability, under certain circumstances, to generate electricity which can be used elsewhere in the home, or even be fed back to the power company if unneeded. This generating feature is made possible by a special high-efficiency auxiliary electric motor provided to drive the air conditioning unit at night and on cloudy days when solar power is not available. When the available solar power exceeds the demand of the air conditioning unit, the auxiliary motor acts as a generator, producing electricity that could reduce utility costs and lower peakload generating requirements.

All components and controls of the system are incorporated into a compact single package similar in size and appearance to air conditioner condensing units found in homes today. After the first unit was

successfully tested, it was installed and additionally tested in a home at a Tennessee Valley Authority demonstration site in Duffield, Va. The developers are encouraged by test results and predict that the system may be available commercially at competitive prices by the mid-1980s.

NASA Retires ATS–6

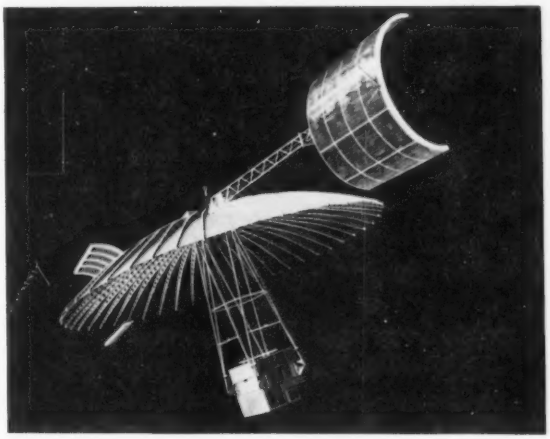
After serving millions of people in communities throughout the world, NASA's experimental Applications Technology Satellite–6 was turned off June 30 and boosted to a higher orbit. The five-year old communications satellite, positioned in a geostationary orbit 35,900 kilometers above the equator in the central Pacific Ocean, exceeded its planned life span by three years.

Three of its four station-keeping thrusters had failed and the lifetime of the fourth thruster become questionable. Should its fourth thruster have failed, the spacecraft would have drifted between its old position above 140 degrees W. longitude and 70 degrees W. longitude, creating a potential hazard to present and future spacecraft in that orbital area. To prevent such an occurrence, controllers at the Goddard Space Flight Center on Aug. 6 used the remaining thruster to boost the spacecraft several hundred kilometers higher, where it will remain in orbit for hundreds, perhaps thousands, of years.

The 1,402-kilogram spacecraft has a 9-meter diameter mesh antenna which can be pointed, within a tenth degree of arc, directly toward small ground receiving stations. This capability to transmit directly to small ground receivers provided unprecedented experimental opportunities to bring educational, scientific and health programs to communities throughout the world. Previously, huge ground stations were needed to receive and amplify the relatively faint signals, after which the video and sound had to be retransmitted overland, via conventional methods, to local television sets.

The spacecraft's string of "firsts" is a chronology of space age applications and technology utilization. For example:

- The first educational course ever taught via satellite television was conducted in 1974. More than 600 elementary school teachers in eight Appalachian states participated in graduate-level studies.
- First satellite air traffic control and communications experiment. The Federal Aviation Adminstration and U.S. Coast Guard (Department of Transportation) and the Maritime Commission participated.
- First successful satellite-to-satellite communications experiments, providing the feasibility for a Tracking and Data Relay System to support Space Shuttle missions in Earth orbit.
- Direct TV support for the Apollo Soyuz Test Project mission provided the live spacecraft video to viewers in both the United States and the Soviet Union in July 1975.
- From August 1975 to August 1976, it transmitted the first satellite broadcasts to inexpensive ground receivers throughout India bringing educational and health information to millions of viewers in 2,500 remote villages.
- The first social experiments in health and educational telecommunications by satellite were offered to hundreds of small communities in remote areas of the Rocky Mountain states, the Appalachian region and Alaska.
- The first medical information network experiments to demonstrate medical techniques for doctors, and health care techniques for people in remote areas, were conducted jointly by the Veterans Administration, the University of Washington, the Alaska Health Department, the Department of Health,



Artist's view of ATS–6, in orbit since 1975.

Education and Welfare and NASA. Through telemedicine, a physician actually prescribed treatment through two-way voice-video communication.

- First full-duplex teleconferencing (two-way color TV and audio), with 27 lesser-developed countries of the Third World was conducted by the State Department, NASA and other U.S. agencies to demonstrate the usefulness of satellite technology.

The extent to which Applications Technology Satellite–6 has broadened the scope of space experimentation is yet to be defined inasmuch as the effect of such new technology continues to be measured.

Experimental data in climatological studies, satellite drift and the use of millimeter waves, in selected frequencies, and radio frequency interference studies are expected to provide information that will permit more effective use and regulation of radio transmissions through better understanding interference with satellite communications by ground communications systems. This knowledge will contribute substantially to the improvement in design of future communication satellites.

ATS-6 is managed by the Goddard center. All operations are coordinated and controlled from its operations control center in Maryland.

Fairchild Industries, Germantown, Md., was the prime contractor responsible for development, integration and test of the spacecraft. Other members of the industry team were:

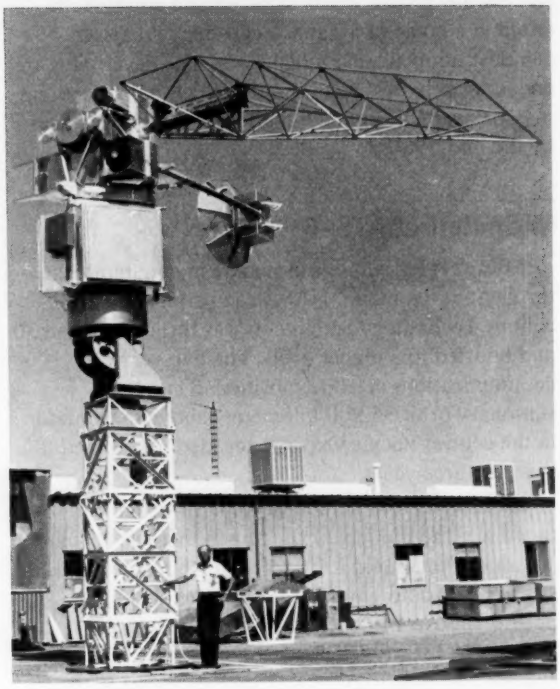
Philco-Ford, Western Development Labs Division
Palo Alto, Calif.
(Communications module)

IBM, Gaithersburg, Md.
(Telemetry and command system)

Honeywell Aerospace Division
St. Petersburg, Fla.
(Attitude control system)

Lockheed Missile Space Center
Sunnyvale, Calif.
(Nine-meter parabolic reflector)

Launch agency for NASA was the Space Missile Systems Organization of the Air Force Systems Command, El Segundo, Calif. Launch vehicle assembly, check out and launch of the Air Force's Titan III–C was performed May 30, 1974, by the 6555th Aerospace Test Group at the Canaveral Air Force Station. Prime contractor for the Titan is Martin Marietta Aerospace, Denver.



Landsat Mockup—At New Mexico State University, a full-scale model of Landsat is used to measure and test the antennas to be used on the real thing. Testing, which is done from a mountain tower, is done by the university's Physical Science Laboratory for the Goddard center, in anticipation of the 1981 launch of Landsat D. Photograph shows the principal investigator, Cecil Post, standing beside the mockup, which was built by PSL personnel.

Award Winner—Kennedy Space Center Director Lee R. Scherer (left) displays the engraved plaque he accepted on behalf of the center, awarding William Clautice first place prize of $4,000 from the James F. Lincoln Arc Welding Foundation. Clautice's winning entry describes an automatic welding technique used in fabricating components for the Space Shuttle. He is a retired KSC metallurgist.

NASA to Study Space Platform

NASA has awarded a study contract for the purpose of defining the concept of a space platform to operate in geostationary Earth orbit—one that would accommodate a large "cluster" of separate payloads on a single orbiting structure. That means a place in space that could eventually, by means of plug-in devices, be a center for scientific investigations involving communications, Earth resources, meteorology and the like. The orbiting platform might do the work of present-day satellites flown as self-contained units.

The Marshall Space Flight Center awarded the contract to General Dynamics Convair, San Diego, Calif., for a study to determine the feasibility and define the systems for such a platform.

Comsat Corp., Gaithersburg, Md., will be the major subcontractor. Total amount of the study contract is $250,000.

Preliminary studies done at Marshall indicate it would be feasible for such a platform to be constructed in space and placed in an orbit synchronized with the Earth's rotation. In this 40,000-kilometer-high orbit, the platform would remain above a given spot on the Earth's equator. There it could provide electric power, stabilization and housekeeping functions to various tenant mission devices parked on it, in return for a use fee, not unlike rent.

Previous studies indicated that geostationary platforms might offer many benefits over today's individual specialized satellites. The platform's common services, available to all tenants, would eliminate the need to put antennae, batteries or solar power arrays on each individual device, thereby reducing the size and launch weight of each. The centralized location of a number of packages on one platform would also make on-orbit repair work and servicing easier to conduct.

Communications satellites, in particular, could benefit from a platform approach. It would reduce crowding in the high traffic areas of space, provide more efficient use of available frequencies, and make it possible to use smaller, less expensive ground terminals.

Eventually, platforms might be located at several positions around the globe to serve the needs of densely populated areas such as the United States, South America, Western Europe and India. Communications links might be established between these platforms, allowing around-the-world communications without the need for relays through ground terminals.

The study is one of several being planned by Marshall to investigate the mission needs of potential users, the technical feasibility of the concept and the potential benefits a geostationary platform might provide.

Astronaut Defies Gravity in Biplane!

The following article was contributed by the Tactical Air Command, Langley Air Force Base.

The shiny-bright biplane shuddered as the 235-horsepower radial engine roared into life. The wind whistled across the fabric skin of the old bird as the pilot completed his checks, revved up the engine to check his few instruments, and prepared for departure.

The scene was reminiscent of the early age of flying machines. Nonetheless, it actually took place early one Saturday morning in early 1979 on the Bergstrom Air Force Base (Texas) flight line.

The aircraft was a Navy N3N trainer, built and flown in the late 1930s, now owned by Confederate Air Force member Charles Day of San Angelo, Texas. Painted in brilliant red, yellow and blue colors of a flying squadron common to the era, the open-cockpit tail-dragger is one of only three NSNs in the world still flying. The bird, most uncommon to the base flight line, stopped overnight on its way to an airshow and, just as uncommon was the history and life of the aviator piloting the craft. At the stick was retired Air Force Col. Stuart A. Roosa, one of three NASA/Apollo–14 astronuats.

Roosa, now living in Austin, Texas, retired from the service in 1976. On Jan. 31, 1971, he rocketed from earth on a nine-day journey into deep space that would take him and his partners, Alan Shepard and Edgar Mitchell, to the Moon's surface and back.

"There's quite a contrast in the complexity of systems between ships," said Roosa, his NASA and Apollo 14 patches prominently displayed on one of his old flight suits that reflected thousands of hours of all sorts of flying. "In the biplane, the basic instruments are an airspeed indicator, an altimeter and an oil pressure gauge. The complicated spacecraft was, as one can imagine, a bit more sophisticated."

Apollo 14 was destined to make history as the third space mission having a Moon landing that differed from two earlier launches because the lunar

module "landed in the lunar highlands," according to Roosa. "I stayed in lunar orbit and didn't go down onto the Moon on the mission," explained the space traveler.

The 382,942-kilometer journey from planet Earth to the Moon and the lunar orbitings were quite different from the trip that astronaut Roosa was about to take—in an antique machine, 600 meters above the ground, a little faster than the cars on the freeway below, to an airport nearly 48 km from Austin.

"Pull the chocks when I get it cranked," shouted the pilot, strapped snugly in the rear cockpit. His 16-year-old son, Allen, in the front cockpit, made mental preparations for the launch. The smoke belched from the exhaust stacks as the machine fired up.

Then, with a smile and a wave, Stuart Roosa, who once propelled from the earth's gravitational bounds at a mere 40,225 km/h, coaxed the bright yellow N3N onto the runway, gave it some gas, steered it into the stiff crosswind, and roared into the air at a blazing 97 km/h.

Old Timers—Silhouetted against the morning sun, retired Air Force Col. Stuart A. Roosa, Apollo 14 astronaut, prepares his friend's Navy N3N for launch on the Bergstrom Air Force Base flight line.

Wind Turbine Generator for Medicine Bow

A large wind turbine generator will be purchased and installed at Medicine Bow, Wyo., under an interagency agreement just completed by the Bureau of Reclamation of the Department of the Interior and NASA.

"This joint effort in the development of renewable resource energy explores the potential of tying utility-sized wind energy generators to hydroelectric power," sad Secretary of the Interior Cecil D. Andrus. "Hydro can firm up the vagaries of wind generation and provide for energy storage to meet peak demand."

A 1- to-5-megawatt-size wind turbine generator will be installed at Medicine Bow to verify the design of the wind generator to be selected and the hydroelectric system integration concept. In addition, the Bureau of Reclamation will monitor any impact on the surrounding environment.

The expertise of NASA's Lewis Research Center in installation, testing and operation of large wind turbine machines will be used by the bureau to obtain information about wind energy technology and to train bureau personnel for possible future installation and operation of such units. The Medicine Bow area has been identified as having a highly promising wind resource that could be coupled with the existing hydroelectric system within the Colorado River Storage Project.

Reclamation engineers developed the concept of integrating wind turbine generators with existing hydroelectric systems, and the lower Missouri regional office in Denver, Colo., started a study in October 1977 designed to:

- test the concept of integrating wind and hydroelectric generation facilities for production of large amounts of additional electric energy;
- determine the environmental impacts of wind energy generation within the study area;
- evaluate the feasibility and justification for constructing a large-scale wind farm;
- measure the acceptance and reaction of the public to the plan.

The acquisition and operation of this large wind turbine generator by 1981 will complete the first phase of the Bureau of Reclamation's wind-hydroelectric integration study.

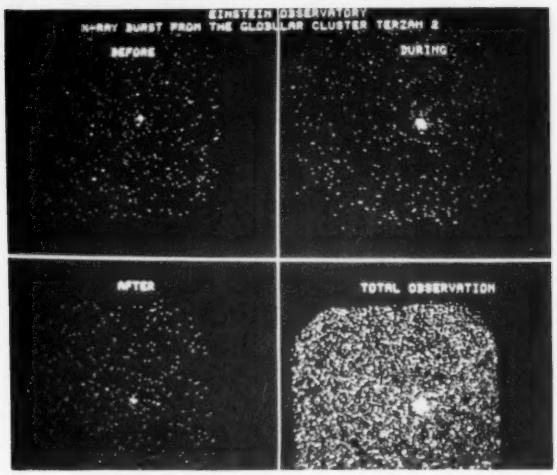
First X-Ray Burst Picture Taken

For the first time, the X-ray telescope aboard NASA's High Energy Astronomy Observatory 2 has photographed an X-ray "burster," one of the most bizarre celestial phenomena ever observed.

X-ray bursters are relatively rare. Compact objects with an apparent diameter of less than 50 kilometers bursters are characterized by sudden, very intense increases in X-ray brightness.

A typical X-ray burst releases more X-ray energy in 10 seconds than our Sun does in an entire week.

And despite a great deal of observational and theoretical study in the three years since X-ray bursters were discovered, their nature is still not understood. The bursts may arise from explosions similar to a helium bomb on the surface of a neutron star or from violent instabilities in the flow of gas down a "black hole."



The accompanying picture was obtained in March by Jonathan Grindlay and other X-ray astronomers at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. The object was observed for 20 minutes, although the burst itself lasted only about 50 seconds; it is located within 2 arc seconds of the center of a globular cluster called Terzan 2. Globular clusters are spectacular round swarms of, typically, 100,000 stars and are the oldest objects in our galaxy.

Thus, in one 20-minute observation with the X-ray observatory on HEAO (nicknamed "Einstein" by scientists) the existence of a "steady" and bursting X-ray source in the globular cluster was established, confirming an identification suggested earlier by Grindlay. This brings the known number of globular clusters containing X-ray sources to at least eight, of which at least six are also bursters; more than 130 globular clusters are known in our galaxy.

According to Grindlay, recent discoveries made it clearer than ever that something remarkable is occurring in the cores of globular clusters. It may be that they have collapsed to form massive black holes, or it may be that compact binary systems containing either neutron stars or black holes are being formed to produce bursting X-ray sources. The black hole hypothesis predicts that the X-ray sources should be located very near the centers of the globular clusters since, as the heaviest object, the black hole would sink to the cluster center.

X-ray bursters were first discovered by Harvard-Smithsonian instruments aboard a Dutch/U.S. cooperative satellite in 1976.

Wind Power for New England Island

A single large wind turbine capable of supplying 5 to 15 percent of Block Island's electricity was dedicated June 15 at the Rhode Island resort and fishing community. This is the third experimental machine of its size to be put into operation by the U.S. Department of Energy and NASA through the Lewis Research Center.

The turbine, an experimental machine, will provide experience to help build and operate better wind turbines in the future. Built by Westinghouse Electric Corporation and Lockheed Aircraft, it is the first federal wind turbine on the East Coast and the only one to be tied into a utility system that is otherwise totally dependent on oil. The other federal wind turbines are in Clayton, N.M., and Culebra, Puerto Rico.

"A commercial wind turbine of this size would save Block Island more than $30,000 a year in fuel costs," said Dr. John Deutch, Acting Under Secretary of the DoE. "Savings from this experimental machine may be less because we're still in a learning process," he added.

Because all the power on the island is generated from expensive diesel fuel that must be brought in by barge, electric rates here are among the highest in the nation—about 20 percent higher than New York City rates, for example.

The wind turbine, with its 125-foot propeller-shaped blades, will generate 200 kilowatts of electricity in an 29-km/hr, which is the average wind speed on the island. In the windy winter months, it could produce almost 50 percent of the power needed by the island's 500 permanent residents.

Full-time operation of the Block Island system will begin soon after a cable television system has been installed to eliminate a potential problem of interference with TV reception when signals are reflected from the aluminum blades. Research on such interference was one of the reasons for selecting the Block Island site.

Because the project here is an experiment, the cost of both the wind turbine and the cable TV system are being borne by the DoE, with support from the Rhode Island Public Utilities Commission and the

Narragansett Electric Company, which joined the Block Island Power Company in proposing the Block Island site to DoE.

The turbine will be operated for DoE by the power company for at least two years to test its effectiveness and reliability. It then may become the responsibility of the power company to continue its operation.

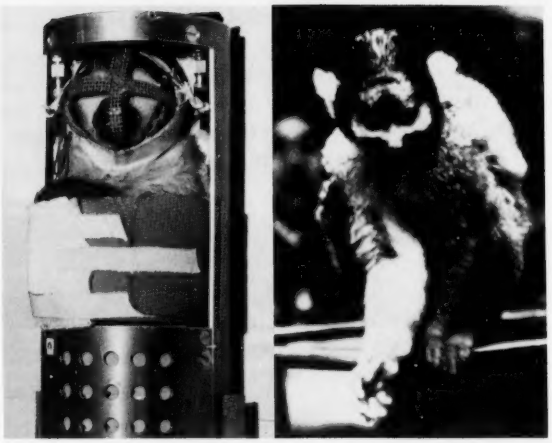
Wind power is one of several alternative sources of energy being developed by DoE. Development of the large turbines is conducted under the operating and technical supervision of the Lewis center. In addition, an extensive program to develop cost effective small machines for farmers and rural residences is being conducted through a DoE facility in Colorado.

Block Island is an almost ideal site for testing a turbine of the 200-kilowatt size," said Dr. Deutch. "It is one of the windiest places in the country. The prevailing windspeed is just right for this type of turbine to produce its full power.

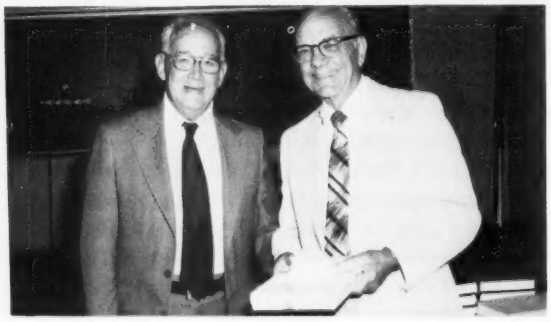
"It's a small community where 200 kilowatts of wind-generated electricity can make a difference. When these wind turbines come onto the commercial market, towns like New Shoreham (Black Island) are going to be interested in them.

"The company that will operate the wind turbine is very small and is not connected to any other power source. This means we'll learn both the good and bad effects of having a substantial part of the power generated by a source that is unpredictable but also is unaffected by rising fuel costs.

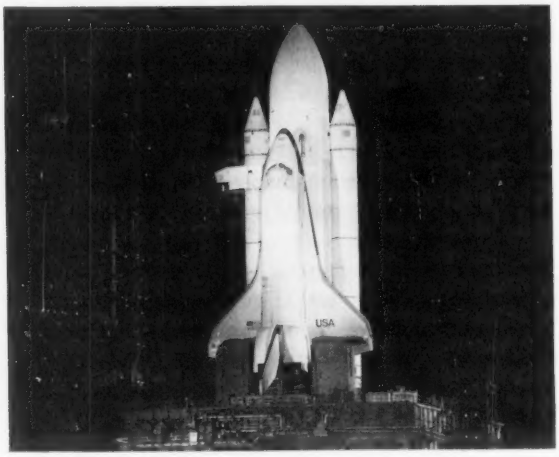
"And the people of Block Island have welcomed the wind turbine and are willing to be part of an experiment with new power sources."



Twenty Years Ago and Counting—"Miss Baker," the tiny monkey which shared a Jupiter missile nose-cone with a colleague named Able in a ballistic flight into space in May 1959, is still alive and well at the Alabama Space and Rocket Center. In the old photo (left) the young monkey is secured in her "cockpit" shortly before the flight. At right, in a recent photo, she mugs for the camera. Able and Baker soared to an altitude of 8,500 kilometers in 16 minutes and 3 seconds. The first living creatures to return alive from space, both survived the flight.



Wallops History—Joseph A. Shortal (right) a retired NASA veteran, is presented with the first hard-bound copy of a book he wrote on the early history of the Wallops Flight Center. Robert L. Krieger, Wallops director, presented the book, "A New Dimension, Wallops Island Flight Test Range: The First Fifteen Years," in a special ceremony at Langley Research Center.



In the Spotlight—Among the many checks performed with the Space Shuttle orbiter *Enterprise* at Kennedy Space Center's Launch Complex 39A was a high intensity lighting systems test. The facility verification vehicle was lit up as the actual Space Shuttle will be for evening operations, such as countdown demonstration tests or fueling, using a number of 20KW xenon searchlights strategically grouped around the perimeter road.

Thailand to Build Landsat Ground Station

A Landsat ground station will be established in Bangkok, Thailand, according to a recent memorandum of understanding signed by NASA Administrator Dr. Robert A. Frosch and Ambassador of Thailand Klos Visessurakarm. Ambassador Klos signed on behalf of the National Research Council of Thailand which will build and operate the new ground station in Bangkok, to receive, process, archive and disseminate Landsat data.

The agreement provides that the National Research Council will make the Landsat data it receives available to anyone requesting it. The council also agrees to help share the cost of operating the Landsat satellites by paying NASA the annual access fee of $200,000 beginning six months after the Bangkok station begins receiving data.

Six Landsat ground stations now are in operation outside the U.S.: Prince Albert, Saskatchewan and Shoe Cove in Newfoundland, Canada; Chiaba, Brazil; Fucino, Italy; Kiruna, Sweden; Tokyo, Japan. A seventh station near Tehran, Iran, which began receiving data last fall, interrupted its operations in January. Three other foreign stations are under construction in Argentina, Australia, and India, and a number of others are in the planning stages.

U.S. ground stations for Landsat are located at Fairbanks, Alaska; Goldstone, Calif.; and at the Goddard Space Flight Center.

Landsat data in use by scientists and local officials in the U.S. and by more than 100 foreign countries bear on a wide variety of applications ranging from crop inventories to flood assessment and mineral exploration. Thailand, an early participant in the Landsat program, has continued to make successful use of Landsat data for such projects as monitoring its rice crops and mapping forest cover.

Weather Data System Could Save Quantities of Fuel

A NASA-developed satellite system designed to collect and relay enroute weather observations from aircraft may save millions of dollars in aviation fuel costs annnually.

The system, called Aircraft to Satellite Data Relay (ASDAR), is operating as part of a worldwide, year-long, international weather experiment called the Global Weather Experiment, part of the Global Atmospheric Research Program (GARP) which began in January 1979. The experiment is a weather monitoring project being conducted under the auspices of the United Nations World Meteorological Organization and the International Council of Scientific Unions.

The ASDAR system monitors and reports the location and altitude of an aircraft together with atmospheric temperature and wind speed and direcion (as measured by the aircraft) eight times each hour. The collected information is then relayed to data centers and thence via a National Oceanic and Atmospheric Administration on-station geosynchronous satellite. NOAA is part of the Department of Commerce.

Rapidly changing weather information gathered by earlier flights can be relayed to subsequent flights within two hours, saving time and fuel because the aircraft can take advantage of favorable winds and thus avoid real or threatening storm areas.

NASA scientists hope that ASDAR will aid in improving long-range weather forecasting inasmuch as some of the 17 wide-body jets used for data collecting in the ASDAR system encompass areas in which observations are difficult to obtain, namely the tropics and the southern hemisphere.

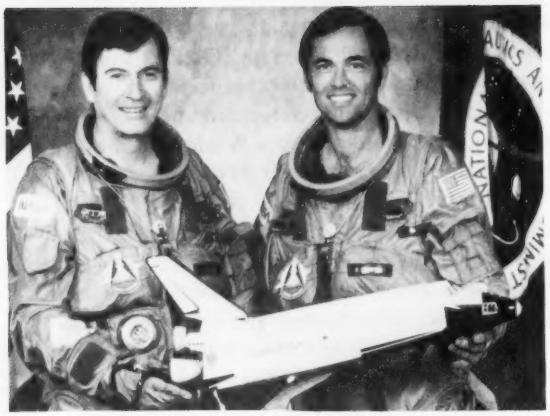
ASDAR units consist of power supply, clock, 80-watt transmitter, small computer and an antenna. Weather information is generated from instruments already carried aboard each of the ASDAR-equipped commercial airliners.

Commercial air transport carriers from England, the Netherlands, Scandinavian countries, Australia, Singapore, and the United States are taking part in the experiment. Airlines from other countries may take part later.

Other U.S. groups involved in the experiment include the Departments of Defense, Energy, Transportation, the Environmental Protection Agency, and the National Science Foundation.

NASA's Lewis Research Center, at which ASDAR is being developed, maintains a computer terminal for assessing the accuracy of the data is they are received.

Managers of the system estimate that the $1 million cost of ASDAR is but a fraction of the several millions of dollars expected to be saved each year in aircraft fuel alone.



Future Spacemen—These two astronauts are the prime crewmen for the first flight in NASA's Space Transportation System (STS–1) program. John W. Young (left) crew commander, and Robert L. Crippen, pilot, will man the Space Shuttle orbiter 102, *Columbia*, for the first orbital flight test.

Goddard Entertains "Fortune 500" Executives—The Goddard center recently played host to 70 top research and development and marketing executives from leading U.S. industrial non-aerospace firms. Sponsored by the American Institute of Aeronautics and Astronautics, the Goddard visit was the first in the series by the group, which will be welcomed at other NASA centers during the next 12 months. Purpose of the series program is to acquaint the industrial community with NASA technology. The group toured the various technical facilities and was briefed on several aspects of space science, technology and developments. Members were given a list of all NASA research and technology subjects along with names and phone numbers and invited to be in touch for information on industry-related problems. Photo shows Earl Angullo, of Goddard's spacecraft devices section, demonstrating collapsible and extendable booms for spacecraft. The ladder-like tower at photo center compresses to fit completely into the small triangular holder at bottom.

Two Award Winners—Dr. W. R. Lucas (left), MSFC director, presented awards to Frank J. Nola of Marshall's electronics and control laboratory ($10,000) and Ms. Barbara S. Askins of the space sciences laboratory ($4,000). Nola's award for his "Power Factor Control System for AC Induction Motors," Askins' for "Method of Post-Process Intensification of Images on Photographic Films and Plates." The first senses the amount of power needed by an electric motor and varies the power supplied according to the need, providing more power when the motor is "working" and less when it is idling. The second was for Askins' original process, developed originally to salvage data from under-exposed astronomy photographs, which applies a low intensity radioactive chemical (*thiourea sulphur* 35) to the silver in exposed photographic film. A negative that has been underexposed by as much as 90 percent produces almost normal photographs using Askins' technique.

New Exhibit at Goddard—The Robert H. Goddard Room at the center recently was dedicated in ceremonies sponsored by the National Space Club and NASA. On display in the new room, part of the Goddard visitors center, are original equipment and memorabilia of the late Dr. Robert H. Goddard, film clips of the rocket pioneer in action, and the Goddard Memorial Trophy Hall of Fame.

Memorials to Four Astronauts

Four islands off the California Coast recently were officially named in memory of four dead American astronauts by the office of Geological Survey in the Department of the Interior.

The islands, all man-made and about a half a kilometer long, lie off Long Beach in San Pedro Bay. City of Long Beach officials in 1967 christened them as Island Chaffee, Island Freeman, Island Grissom and Island White and the names became official upon recognition by Geological Survey. The islands are so designated in Geological Survey maps, National Ocean Survey (NOAA) charts and all other maps or listings produced by U.S. federal agencies.

The listings honor by name, birth date and date of death:

- Roger B. Chaffee (1930–1967), Lieutenant Commander, USN, died in Apollo spacecraft fire at the Kennedy Space Center.
- Theodore C. Freeman (1930–1964), Captain USAF, died in T–38 crash at Ellington Air Force Base, Houston, Texas.
- Virgil I. Grissom (1926–1967), Lieutenant Colonel, USAF, died in Apollo spacecraft fire at the Kennedy center.
- Edward H. White (1930–1967), Lieutenant Colonel, USAF, died in Apollo spacecraft fire at the Kennedy center.

Special Staff to Aid in Assessing Shuttle Problems

NASA management has requested special senior staff support to assess the management of the Space Transportation System.

The staff consists of: Dr. Richard C. McCurdy, former NASA Associate Administrator for Organization and Management; Willis H. Shapley, former NASA Associate Deputy Administrator; Maj. Gen. James Abrahamson, F–16 Program Director, United States Air Force; A. Thomas Young, deputy director, NASA Ames Research Center,; and John E. O'Brien, assistant general counsel for procurement matters at NASA headquarters. Abraham Spinak, associate director, NASA Wallops Flight Center, is executive assistant.

The staff will assist in the study of Space Shuttle funding problems, uncertainties of program predictions and information flow and control proceses.

Dr. Alan Lovelace, Deputy Administrator, said: "With the assistance of this special staff, I feel we can develop a thorough assessment of the major management issues."

Pioneer Crosses Orbit of Uranus

Pioneer 10, the first spacecraft to approach and investigate the planet Jupiter and the first to head out of the solar system, crossed the orbit of the planet Uranus on July 11, 1979.

The seventh planet out—Neptune and Pluto represent the outer limits of planets within our solar system—Uranus is 2.9 billion kilometers from the Sun and about 2.7 billion km from Earth. The planet takes 84 Earth years to orbit the Sun.

Cornell University astronomers aboard the NASA-Ames Research Center's Kuiper Airborne Observatory discovered two years ago that Uranus has five rings—the first major discovery in the solar system since Pluto was identified in 1930. On the March 1977 expedition, scientists detected the rings when they blocked out the light from a star. Before that discovery, scientists had thought Saturn's rings were unique in the solar system. In December 1973, Pioneer 10 returned the first closeup views of Jupiter, its huge red eye, and its four planet-sized moons. The satellite's imagery made possible a variety of discoveries about the planet's magnetic field, radiation belts and weather.

The spacecraft was launched March 3, 1972, for the first flight beyond Mars and through the asteroid belt, dispelling theories about an asteroid barrier to outer planet exploration. Mission planners used Jupiter's gravity to hurl the spacecraft on an escape trajectory out of the solar system.

After its historic visit to Jupiter, Pioneer 10 went on to cross Saturn's orbit in February 1976. After passing the Uranus orbit, the spacecraft then headed for Neptune, and on to the expected limit of radio communications when it crosses Pluto's orbit in 1987. Later it will leave solar-influenced space, crossing the boundary into interstellar space.

The 259-kilogram spacecraft continues to perform well, returning valuable data about characteristics of unexplored space in the outer solar system.

Pioneer 10 is headed generally in the direction of the red star Aldebaran, the center of the constellation Taurus. Its ultimate destination, relative to the constellations, cannot now be calculated because scientists don't know enough about motions of

the stars. Once it leaves the solar system, the spacecraft's radio signals will be too faint to be detected on Earth. The vacuum of space is expected to preserve Pioneer in good condition, but its nuclear power source will cease to function in a few decades. Scientists calculate that as it wanders through the galaxy, Pioneer 10 will encounter a star system—like our own solar system—about once every million years.

Pioneer 11, identical twin to Pioneer 10, is now making the first trip to Saturn. Pioneer 11 added greatly to knowledge of Jupiter by taking the first look at the planet's polar regions (not visible from Earth). Pioneer 11 made its inspection of Jupiter in December 1974. It will reach Saturn this September, thus becoming the first spacecraft to encounter the planet. Pioneer 11 will fly under the rings, sending back the first photo images of these unusual structures.

After its encounter with Saturn, Pioneer 11 also will head out of the solar system. This second Pioneer will travel in roughly the same direction followed by the solar system as it moves through the interstellar gas, or in a path nearly opposite to that of Pioneer 10. It may therefore reach interstellar space before Pioneer 10 does.

Each Pioneer carries a plaque with an explanatory message about its origin for any intelligent species that may intercept the spacecraft during its endless journey through the cosmos.

Pioneers 10 and 11 are managed by the Ames Research Center. The spacecraft were built by TRW Systems, Redondo Beach, Calif.

Satellite Tracks Clipper Ship Movement

An interesting blend of the old and the new took place recently when the high technology of space helped solve a major navigational problem for an 18th century sailing vessel.

The occasion was the installation by the Goddard Space Flight Center of a special beacon aboard the "Pride of Baltimore," a 28-meter exact replica of a clipper ship built and owned by the City of Baltimore. The 4½-kilogram device makes it possible to accurately track the ship within a few kilometers anywhere in the Atlantic region via the Nimbus–6. The research satellite will monitor beacon signals from the vessel and report its location to Goddard.

The vessel became a news item not long ago when it seemed that she might have been lost at sea. Following an intensive search by ships and aircraft of the U.S. Coast Guard, and U.S. Navy, the "Pride" made a landfall in Delaware Bay and ran aground on a shoal after it was blown off course by storms.

Space-age Technology for Clipper Ship—Crewmen installed an antenna high on a mast of the "Pride of Baltimore" as she lay at anchor. The vessel sends a one-second signal every minute, which is received by the Nimbus–6 satellite, to pinpoint specific location.

The satellite beacon now aboard the ship is a compact battery-powered unit that automatically transmits a one-second signal every minute. Latitude and longitude positions are computed, using the frequency shift of the successive signals received by the Nimbus–6 satellite as it passes overhead.

The beacon originally was developed for use aboard constant-level weather balloons in the tropics to relay meterological data to land bases. Today the devices are used extensively on buoys to track ocean currents for oceanographic and environmental impact studies around the globe.

Beacons also are used by the U.S. Coast Guard to help track the drift routes of icebergs in the Greenland and Labrador areas for the international Ice Patrol. Some are used by animal researchers to track polar bears in the Arctic, and supply biological data about the animals.

The beacon played a key role in helping locate two American balloonists attempting to cross the Atlantic Ocean in 1977. The aeronauts credit the beacon with helping save their lives when, lost in a snow storm, they had to ditch in the ocean. All their communications equipment had failed.

The Goddard visitor's center features a special exhibit demonstrating how the beacon operates and pinpointing the daily location of the vessel through use of a model of the ship which is moved around on a world chart.

Minority Employment High at Remote NASA Station

Guam, in the Mariana Islands, is the site of one of 15 tracking stations that make up NASA's Spaceflight Tracking and Data Network (STDN), under the management of the Goddard Space Flight Center. The staff of 117 employees not only is responsible for one of the highest performance records in the network, but represents the attainment of enviable advances in equal opportunity employment for minorities and women.

Minorities make up more than 50 percent of the employees currently assigned to the Guam tracking station, including 43 Guamanian-Americans. Many of the employees work at highly technical and complex jobs.

Efforts by station managers, NASA and the Bendix Field Corp. to locate and develop local talent have been intense since the station was activated in 1966 to support national and international space programs. The Guam vocational technical high school has been an excellent source for young people with talent and motivation. The school offers courses designed to prepare students for careers in fields such as electronics. Working closely with the school, station personnel arrange field trips to the station, which may last several days. They allow students to get first-hand looks at the operation of the complex tracking and data acquisition facility. After receiving on-the-job training, many of the students have attended advanced technical courses at Goddard's Network Test and Training Facility where they have been certified as electronic technicians. As a result of such extensive training and work experience, many local employees have been transferred to other tracking stations from which they perform essential functions for the STDN.

Advancement and progress made by minorities and females readily can be seen in the current assignments of these employees: One of the four systems-section supervisors and eight of 16 shift-lead technicians are members either of minority groups or they are women.

In the communications section, two of the four high-speed data technicians and all four teletype operators are women, many of whom have moved into the technical areas from clerical jobs. As technican positions become available, qualified employees who move into the technical areas then are trained and promoted into the vacant jobs.

Remote Smokestack Monitoring System Developed

A laser system developed jointly by the Marshall Space Flight Center and the Environmental Protection Agency to measure pollution emissions from smokestacks at coal-burning power plants was delivered in early May. The "laser doppler velocimetry system" was tested at the Duke power plant at Charclotte, N.C., where EPA personnel who will operate it were trained in its usage.

Aubrey D. Smith, head of the Marshall center's Technology Utilization Office, said the new system will eliminate two costly and time-consuming steps the EPA has been forced to follow in past years. Under existing procedures, arrangements must be made with plant officials for the EPA to enter a plant, then sensors must be installed on the smokestacks to obtain samples for analysis later, and finally the sensors must be removed.

The new mobile system is carried in a van and has a remote measurement range of about 600 meters.

To measure wind direction and velocity, the laser beam can be reflected by a series of mirrors in a scanning pod on the roof of the van near the rear, or it can be directed through a door in the side of the van to measure emissions. The van contains all ancillary equipment and instruments, heating, air-conditioning and power systems needed for independent operation.

EPA personnel will be able to park within range of a smokestack, aim and focus the laser beam just above the lip of the stack and record the velocity of the emission. It also will perform velocity-azimuth-display wind profile measurements.

Smoke coming out of a stack causes the carbon dioxide laser beam to bounce back to the van. The frequency of the returned beam is different from that

of the outgoing beam. This change in frequency is called "doppler shift." Velocity of material being emitted is determined by measuring this doppler shift.

Technology for the laser system was demonstrated many years ago at the Marshall center and adapted by the center to fit the needs of EPA in monitoring smokestack emissions. The doppler-shift principle has been employed in other projects, such as vortex propagation by airplane wingtips and clear-air turbulence studies.

By calibrating the instruments with known quantities (amounts of particles actually measured by sensors) at one site, the operators will be able to compute the mass (number and size) of particles entering the atmosphere at other sites. It also can be used at oil-burning plants and other industrial sites where air pollutants are generated.

Advantages of the new system are obvious: It is self-contained and easily moved and can be used anytime without interfering with plant operations. It is safer, economical and supplies instant data.

Officer for the project is John Richardson, and project engineer is James W. Bilbro of Marshall's electronics and control laboratory. The laser system was provided and installed by the equipment division of the Raytheon Company.

External Relations Officer Leaves NASA

Arnold W. Frutkin, NASA Associate Administrator for External Relations, retired from federal service in late June.

His position entailed responsibility for NASA activities and policies dealing with the public, the international community, universities, state and local government and other federal agencies.

Frutkin was appointed to his present position Nov. 9, 1978 after serving as Acting Associate Administrator and Deputy Associate Administrator for External Affairs.

He received the NASA Distinguished Service Medal, the NASA Exceptional Service Medal, the National Civil Service League Award and awards from foreign governments and organizations.

Frutkin came to NASA in 1959 from the National Academy of Sciences, where he had been deputy director of the U.S. National Committee for the International Geophysical Year.

NASA Administrator Frosch's official announcement said: "Arnold Frutkin will be sorely missed; as a valued contributor to NASA and the nation for over two decades, his dedication, judgment, and integrity have been responsible for much of the prestige the United States space program enjoys today throughout the world."

A native of New York, Frutkin did his undergraduate work at Harvard College and graduate work at Columbia University. He served in the Pacific during World War II and is a retired Navy commander.

NASA Center to Provide Technical Management for Solar Energy Program

The Department of Energy has announced a $69 million program designed to stimulate the use of solar energy to heat and cool federal buildings, for which the Marshall Space Flight Center will provide technical management support to DoE in administering the program.

The primary purpose of the three-year, solar-in-federal-buildings program is to demonstrate the confidence the federal government places in solar energy as a currently viable energy source by purchasing and using commercially applicable solar heating and cooling equipment in federal buildings and installations.

Under terms of the heating and cooling demonstration program, DoE will provide funds to federal agencies for the design, purchase, construction and installation of equipment. A limit of $500,000 will be set for any one project.

DoE requested proposals for projects during July and expects to have the first of three groups of demonstrations selected for funding by the end of 1979. Marshall center technical managers will evaluate the proposals and recommend demonstration sites to DoE.

The Marshall center has been providing technical management support to DoE for the past several years in the solar heating and cooling development program and the commercial demonstration program. More than 150 sites throughout the United States and the Virgin Islands are under technical management of Marshall engineers.

Moon Rock Tracking Kit Passes Quarter-Million Mark

NASA's new Lunar Sample Educational Package (LSEP) already has been seen and studied by almost 300,000 high school students and adults since the kits became available last December. Developed by

"Sam, You Made the Pants Too Long"—Fifth-grader Eddie Cunningham from the Belmont Elementary School, Lincoln, Neb., is almost lost in an astronaut uniform as NASA's Fred Kubesch, Jr. informs students concerning the space program. Kubesch, an aerospace education specialist at the Johnson center, is a participant in the LSEP program. (Credit: Lincoln Sun Newspapers)

the Johnson Space Center, the kit contains six small lunar samples embedded in a plastic disk so that samples can be studied under a standard low-power microscope.

Designed especially for use in high schools, the kit has become an important and exciting teaching aid for classes in Earth sciences, astronomy, chemistry, and other subjects. The lunar samples in the kit include a piece of volcanic lava from the dark lunar "seas", a white aluminum-rich rock from the lunar highlands, and several specimens of the powdery "soil" from the lunar surface, including the famous orange soil collected by the Apollo 17 astronauts. The sample disk is accompanied by a slide show that describes the discoveries made by the Apollo program and the importance of lunar samples to an understanding of the early history of the Earth and the past life of our Sun.

The kits are lent to high schools for brief periods (one or two weeks). Even so, the demand for the first 100 disks has been so great that waiting times now range from several weeks to a few months. To relieve this pressure, another 100 disks are being made by the lunar sample curatorial facility at the Johnson center. Because each kit contains only three grams of lunar material, plenty of samples will remain for years of scientific research after the additional disks are made. (The total amount of lunar material returned by Apollo programs is 381,700 grams.)

To qualify for the loan of one of the LSEP kits, teachers are required to participate in a NASA-supported orientation program that covers basic lunar science and describes the special security arrangements required for handling the samples. After qualification, teachers can apply for one of the kits.

For more information on obtaining one of these kits, contact James D. Poindexter, Code AP–2, Office of Public Affairs, NASA Johnson Space Center, Houston, TX 77058, phone (713) 483-4241.

Contractor News

Computer Sciences Corp., Applied Technology Division, Falls Church, Va., has been awarded a $13 million contract extension for communications and instrumentation support services at the Kennedy center. The cost-plus-award-fee extension provides for the corporation and its subcontractor (RCA Service Co., Cherry Hill, N.J.) to continue support in communications measurements, telemetrics and administrative computer services, and others. The one-year extension brings the total value of the contract to some $50 million and marks the third year of service.

Two auto industry teams—one from **General Motors' Detroit Diesel Allison Division and the Pontiac Motor Division,** the other from **AiResearch Division of Garret Corp.** (in conjunction with the Ford Motor Co.,—have been chosen for negotiations leading to the award of a federal contract to develop an advanced gas turbine engine for autos. The negotiated contract will be the final phase in a DoE effort, in cooperation with the auto industry, to develop the gas turbine as an alternative to the current spark ignition (internal combustion) engine. Negotiations with both teams, to take place simultaneously and result in the award of one contract, will be conducted for DoE by the Lewis center, which manages the automotive gas turbine portion of the DoE's highway vehicle systems program.

A contract with **Northrop Worldwide Aircraft Services, Inc.,** of Webster, Texas, has been extended for a third year by the Johnson center, covering the maintenance and modification of center aircraft operating out of the Ellington Air Force Base. The extension brings the total estimated costs of the contract to $6.6 million, with a maximum award fee of $317,000 for the third year.

Rocketdyne Division of Rockwell International Corp., Canoga Park, Calif., has won a $2 million contract to provide one MA–5 engine assembly for the Atlas Centaur launch vehicle. The fixed price/incentive contract will run for one year. The Lewis center provides management for the Atlas/Centaur launch vehicle program through all phases of manufacturing, testing and launch.

Pan American World Airways, Inc., Aerospace Services Division of Houston has had a contract renewed by the Johnson center for plant maintenance and operations support service at the center. PanAm is responsible for operation of utility systems and maintenance of utilities, buildings, roads, ditches and special equipment at the center. The cost-plus-award-fee contract is valued at about $8.5 million. PanAm employs 274 people to carry out contract responsibilities.

Sigma Data Services Corp. of Silver Spring, Md., has been selected for negotiation of a $3 million, cost-plus-award-fee contract to perform the support services for the Goddard center's modeling and simulation facility. The contract is for two years and includes provisions for a one-year optional extension.

IBM Federal Systems Division of Gaithersburg, Md., has signed a supplemental agreement to its contract with the Johnson center covering 12 changes in Shuttle avionics software. Most of the changes are refinements in software programming resulting from orbiter avionics testing on orbiter vehicles at the Marshall and Kennedy centers and at other component test sites. The supplement is valued at $9 million and brings the total value of the cost-plus-award-fee contract to $114 million.

San Francisco Student Wins Galileo Memorial Scholarship

The 1979 Galileo Memorial Scholarship, the annual competition sponsored by the San Francisco Section of the American Institute of Aeronautics and Astronautics and Ames Research Center, was won by Dana Wayne Tom, a senior at Lowell High School in San Francisco. The five other finalists were William L. Abbott and Marc A. Ullman of Palo Alto Senior High School, May S. Fan of Monta Vista High School in Cupertino, Julia A. Kornield of Los Altos High School, and Paul A. Thompson of Branham High School in San Jose.

Ames director C. A. Syvertson presented the award at the May 3 joint meeting of the San Francisco Sections of the AIAA and the American Helicopter Society. The evening's program titled, "The Quiet Airplane—Evolution from Reconnaissance to Research," featured the Lockheed YO–3A, which made several passes overhead before going on display at the Ames Flight Facility.

The Galileo Memorial Scholarship Program was established in 1973 as a memorial to the men who perished in the accident of Galileo I. Like its replacement Galileo II, Galileo I was a Convair 990 aircraft, modified and operated by Ames as an airborne laboratory for research in aeronautics, astronautics, astronomy, and earth observations. The scholarship program is intended to assist and encourage high school seniors to pursue careers in engineering, mathematics, and the physical or natural sciences.

The scholarship is open to high school seniors who are either residents of San Francisco, San Mateo, Santa Clara, or Santa Cruz County or children of Ames Research Center career employees, retirees, on-site support service contract employes, or Galileo crew members.

The winner is selected on the basis of an essay, limited to 1,200 words, which describes the career that the applicant intends to pursue and the proposed course of study; scholastic standing as determined by grade-point average and scholastic aptitude or other college entrance test scores; a letter of recommendation from a teacher; and an interview by the selection committee.

At least one $750 scholarship is awarded annually. The other finalists receive $100 savings bonds. The scholarship program is supported by the NASA Ames Exchange Council and interest derived from a Trust Fund maintained by the AIAA Section.

Annual Scholarship Ceremony—Ames Director Syvertson congratulates Dana Wayne Tom, winner of the Galileo Memorial Scholarship.

New NASA Publications

"A New Sun: The Solar Results from Skylab" (NASA SP–402) by John A. Eddy contains the scientific results and many of the color photographs of the Sun taken during the Skylab mission with the cameras of the Apollo Telescope Mount installed in the space station. ATM observations have led to many new discoveries about the nature of the Sun and the fascinating events that occur on its surface. The clothbound book, published by NASA's Scientific and Technical Information Branch, consists of 220 pages. It is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $10.50.

"Sun, Weather, and Climate" (NASA SP–426) by John R. Herman and Richard A. Goldberg, is a study of the literature of sun/weather/climate relationships by two scientists who state that the possibility that fluctuations in the energy output of the Sun may affect Earth's climate and weather. They believe that such an effect could prove beneficial if the linking mechanisms can be understood. This book addresses scientific questions that may lead to an understanding of the linking mechanisms between solar activity and climatological and meteorlogical responses. Such an understanding, say the authors, may make possible improvements in predictions of weather and climate, which in turn could contribute to the solution of related social problems. The paperbound book consists of 372 pages. It is sold by the Superintendent of Documents. U.S. Government Printing Office, Washington, D.C. 20402, for $4.50.

Ants to Be First "Family" in Space

The first space colonists will be ants, sent aloft aboard NASA's Space Shuttle Orbiter in an experiment conducted by a group of Camden, N.J., inner-city high school students. The experiment was selected by students involved in "Orbit '81" an educational project sponsored by RCA under a NASA program in which worthwhile space experiments are accepted for Space Shuttle rides.

Purpose of the project undertaken by students of the Camden and Woodrow Wilson high schools is to observe the effects of varying degrees of weightlessness on a colony of ants. The project is considered timely by NASA officials who believe it may contribute to a number of scientific studies and laboratory programs now underway to consider the feasibility of establishing manned colonies in space.

The students found an ant colony a valid choice for various reasons. For one, ants have a hard exoskeleton that will help them survive the grinding forces of rocket liftoff. For another, ants are proven as organisms that can live in small spaces. Their feet have cilia (small hairlike growth) to clasp rough surfaces, which probably can help to prevent them from floating around in a space capsule.

The students' tentative plans call for a three-part space colony that would contain as many as several thousand ants. One section of the five-cubic-foot capsule would be weightless in space, while another would have a flywheel motion to simulate half of Earth's gravity. The third section would be nearly, but not completely, weightless. The full life cycle, including births and deaths, will be monitored by periodic motion and still photography as the ant colony spends seven days in orbit in 1981. The complete space colony, including a microcomputer, monitoring instruments, cameras and ants, will be returned to the students for study following the Shuttle's return to earth.

All types of disciplines, from program management to biology, electronics, optics and chemistry, are involved in the effort. Dr. John Torka, a biophysicist in the Engineering Department at Temple University, is principal technical advisor on the project.

The students will closely study the habits of the ant colony before it leaves for space. Earth habits will then be compared with behavior of the ants in orbit. Among the variables to be observed are the amounts of oxygen, water and food consumed by the

ants, their average weight, the incubation time for baby ants, and the percentage of deaths.

Sponsorship of the project was offered by Irving K. Kessler, RCA Executive Vice President. Although other high schools are conducting space experiments under NASA's "Getaway Special" program, the Camden project is most unique—it is described as the only "total involvement program" covering all the disciplines, arts and skills that are taught in the curriculum.

The ant colony experiment was selected from a number of ideas examined by the students since the Orbit '81 project was announced in early 1978.

Far-reaching Decisions—Camden high-school students debated the merits of several proposed experiments before deciding to send an ant colony into space. The group is involved in "Orbit '81," an educational project aimed at stimulating student interest in engineering and science-related subjects.

Launches for 1979

Name	Launch Date	Vehicle	Range	Mission Remarks
SCATHA	Jan. 30	Delta	ETR	DoD R&D. Spacecraft charging at high altitude Reimbursable.
SAGE-A	Feb. 18	Scout	WFC	NASA applications satellite. Stratospheric aerosol and gas experiment.
FLTSATCOM-B	May 3	Atlas Centaur	ETR	DoD Navy communication satellite. Reimbursable.
NOAA-A	June 27	Atlas-F	WTR	NOAA weather satellite. Reimbursable.
UK-6	June 2	Scout	WFC	UK scientific satellite. Reimbursable.
Navy 20, C/U	July 20	Scout	WTR	DoD Transit Reimbursable.
Westar-C, C/U	August 9	Delta	ETR	Western Union communications satellite.
Intelsat V-A	August	Atlas Centaur	ETR	Intelsat communications satellite. Reimbursable.
HEAO-C	September 14	Atlas Centaur	ETR	Third high energy astronomical observatory to study highly energetic radiation from space.
MAGSAT-A	September 13	Scout	WTR	NASA applications satellite to study magnetic field.
Navy-21	October	Scout	WTR	DoD transit satellite. Reimbursable.
SMM-A	October	Delta	ETR	NASA solar maximum mission satellite.
RCA-C	December	Delta	ETR	Domestic communications satellite. Reimbursable.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) and Employer	Title	Patent No.	Installation
James R. Currie, Ralph R. Kissel, Emsley T. Deaton, Jr., Richard A. Campbell; MSFC	Contour measurement system	4,156,971	MSFC
Richard A. Campbell, Jerry Hudgins, Paul W. Morris, Harry Reid, Jr., Joe E. Zimmerman; MSFC	Coal-shale interface detection system	4,157,655	MSFC
Edward F. Bacher, LeRC	Intra-ocular pressure normalization technique and equipment	4,157,718	LeRC
Floyd A. Anderson, JPL	High performance ammonium nitrate propellant	4,158,583	NRLO
Billy R. Aldrich, MSFC	General purpose rocket furnace	4,158,742	MSFC
William D. Whitt, Ara Chutjian, Joseph M. Ajello; JPL	High resolution threshold photoelectron attachment	4,158,775	NRLO
Charles W. Bright, Lester J. Owens, James B. Reswick, Vert Mooney, Rancho Los Amigos Hospital Rehabilitation Engineering Center, Downey, Calif.	A prosthesis coupling	4,158,895	KSC
Li-chew Hsu, LeRC	Catalytic trimerization of aromatic nitriles and triaryl- S -triazine ring cross-lined high temperature resistant polymers	4,159,262	LeRC
Lawrence H. Thaller, LeRC	Electrochemical cell for rebalancing Redox flow system	4,159,366	LeRC

Large Crowds Attend NASA Exhibit

The NASA exhibit at the Paris Air Show was a popular attraction for the hundreds of thousands of visitors who swarmed over the exhibit site at Le Bourget Airport—even when it *wasn't* raining.

The one-fifteenth scale Shuttle full assembly, the TV monitors showing altitude and landing tests and computer-generated aircraft designs, the films on crash safety, displays of highly advanced aircraft and new techniques were crowd-stoppers and pleasers. Waiting lines to enter the NASA section of the show and outside the full-scale mockup of the Space Shuttle were standard almost all day during the two Saturdays and Sundays of the show.

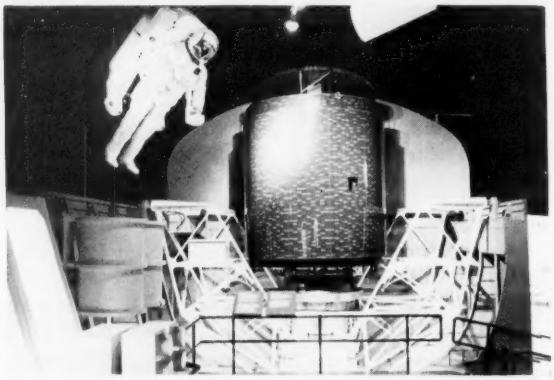
The NASA exhibit was opened officially by Sen. Howard Cannon, President Carter's personal representative. An hour later, French President Giscard d'Estaing and his entourage walked through, with NASA's Dr. Alan Lovelace as guide. Later in the week, visitors of note included U.S. Ambassador Arthur Hartman, King Hussein and Queen Noor of Jordan, USSR Cosmonauts Vladimir Kovalenok and Aleksandr Ivavchenkov, and the group responsible for the cross-channel flight of *Gossamer Albatross*.

Astronaut Deke Slayton and astronaut-candidate Dr. Rhea Seddon played host to some of the visitors and were kept on a full schedule of TV and radio interviews, press conferences, public appearances, and official visits.

The NASA presence appeared to meet its objectives of supporting the U.S. industrial exhibitors bidding for export markets and informing all that U.S. products benefit from NASA research and technology.

Many VIPs Were in Evidence—On opening day of the Paris Air Show, a distinguished visitor was French President Giscard d'Estaing. He was met at the entrance to the NASA exhibit by Deputy Administrator Alan M. Lovelace, astronaut candidate Dr. Rhea Seddon and astronaut Deke Slayton.

International Observers—Officials of the Agency for the Security of Aerial Navigation in Africa and Madagascar (the equivalent of the F.A.A. in the U.S.) posed with Dr. Rhea Seddon and Deke Slayton (center of photo). They are, left to right: Yerima Eyba of Chad; Benjamin Ezin of Bénin; Harvey Leiffert, an ICA information officer; Anatole Tchiboze of Bénin; and Dr. Benjamin Ngoubou of Gabon.



Inside the Shuttle—Looking aft inside the full-scale Shuttle cargo bay mockup. On display at left are two "Getaway Special" canisters; an EVA astronaut; a Satellite Business Systems satellite atop its propulsion unit (at center), and the tip of the remote manipulator at top right.

World Record Setters—Designer, pilot and ground crew of the *Gossamer Albatross*, the first aircraft to cross the English Channel under human power alone, met U.S. astronaut Deke Slayton (center, in plaid jacket), and cosmonauts Vladimer Kovalenok and Aleksandr Ivanchenkov (standing to Slayton's immediate left). *Albatross* designer Paul MacReady is third man from right of photo and *Albatross* pilot (*and* the human engine) Bryan Allen is at extreme right. NASA's revolutionary aircraft, HiMAT, is in background.

Old Acquaintances—Astronaut Deke Slayton (right) reminisces on the Apollo Soyuz Test Project with Soviet Cosmonaut Aleksandr Ivavchenkov, who was on the third back-up crew for the 1975 flight. Cosmonaut Vladimir Kovalenok (left) shares in the conversation.

The EEOC Gets New Responsibilities

Originally the Equal Employment Opportunity Commission was created by the Civil Rights act of 1964 to end discrimination based on race, color, religion, sex or national origin in hiring, promotion, firing, wages, testing, training, apprenticeship and all other conditions of employment.

In 1972, Congress extended the coverage of Title VII of the Civil Rights Act to Federal employment. Until January 1979 the EEOC and the U.S. Civil Service Commission shared oversight reponsibility for equal employment opportunity in the Federal Service.

As a part of President Carter's initiatives on Civil Service Reform, under the Reorganization Plan No. 1, the EEOC received responsibilities previously handled by the former Civil Service Commission. They include:

- review and approval of agency EEO plans;
- review and approval of all affirmative action programs including those for handicapped persons;
- review and overall regulation of the discrimination complaint system;
- review of agency actions on charges of reprisal for bringing discrimination complants; and
- receipt of notices of intent to file civil action under the Age Discrimination in Employment Act.

The Civil Service Reform Act of 1978 (CSRA) represents a major change in responsibility for EEOC. The Reform Act charges the EEOC with determining the extent of under-representation of minorities and women in the Federal Service. Underrepresentation as defined in the "Garcia Amendment" to the Reform Act exists when the percentage of minority group members within a Civil Service category is lower than the percentage of that group in the total U.S. workforce in a comparable category. The CSRA requires that the EEOC transmit such information to the Executive Agencies involved, the Office of Personnel Management (OPM) and Congress. The EEOC also has responsibility under the CSRA to submit proposed guidelines for OPM's minority recruitment program.

EEOC presently is undergoing a reorganization to integrate legal and compliance functions in a decentralized structure of 22 district offices and 37 smaller area offices.

Visitors from China—The Langley center was visited by engineers from the People's Republic of China recently after they made presentations at the AIAA 14th Thermophysics Conference, in Orlando, Fla. The group also visited Kennedy, Goddard and Old Dominion University. Pictured from left to right: Jiang Gui-qing, engineer, Peking Institute of Aerodynamics; Min Gui-rong, Vice Director, Institute of Spacecraft Systems Engineering, National Academy of Space Technology of China (NASTC); Jing Zhao-qian, engineer, NASTC: and Hou Zeng-qi, engineer, NASTC. Walter B. Olstad (center), chief, Space Systems Division, accompanied the men on their tour of Langley facilities.

Shoots Two Covers—Ernest G. Hardin Jr., received recognition recently from "Aviation Week & Space Technology" magazine. Hardin, a photographer at the Marshall center, took the pictures used on the magazine's covers for the issues of June 26 and Aug. 28, 1979. He took the picture at left while under water in the center's neutral buoyancy simulator and the view at right was taken from a wooded area near the dynamics test stand.

Congressional Visitor—Congressman Barry Goldwater, Jr., a member of the House Committee on Science and Technouogy, recently visited NASA's Dryden Flight Research Center to be briefed on current aeronautical research programs underway. In this photo, the Congressman gets a feel for the AD-1 aircraft, soon to be flight-tested at Dryden.

High Photography Award to NASA

The Royal Photographic Society of Great Britain has awarded its Silver Progress Medal for 1978 to NASA's photographic technology division of the Johnson Space Center.

The premier award was for ". . . achievements in extending the applications of photography to space research and in particular for increasing our knowledge of the planetary system, especially the earth and the moon." Since the initial awarding of the progress medal in 1878, this marks the first time the award has been made to an organization.

James P. Morrison, NASA's European Representative, accepted the medal on behalf of the Photographic Technology Division on last May at the Society's annual dinner in London. As a tribute from the Royal Photographic Society to the contributions which NASA has made to photography generally, the medal will be displayed in the Johnson center exhibits area for viewing by all NASA personnel and visitors.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Waterway Ice Thickness Measurements

The ship in the accompanying picture is a U.S. Steel Corp. tanker making its way through the ice-covered waters of the Great Lakes in the dead of winter. The crew is able to navigate safely through open water or thin ice by use of a plotting technique developed by NASA with several other agencies.

Traditionally the Great Lakes-St. Lawrence Seaway System is closed to shipping for several months each winter because of ice blockage, and particularly because of fluctations in the thickness and location of ice cover that result from severe winter weather.

Shippers long have sought a system of navigation permitting year-round operations on the Lakes making possible benefits to national economy. Interruptions in shipping on the Lakes cause national economic difficulties translated into hundreds of millions of dollars each year and involving cargo-hauling by overland methods and other costly alternatives to maritime shipping.

Under Project Icewarn, NASA, the U.S. Coast Guard and the National Oceanic Atmospheric Administration collaborated in development and demonstration of a system that permits safe year-round operations. It employs airborne radars, satellite communications relay and facsimile transmission to provide shippers and ships' masters up-to-date ice charts.

Lewis Research Center contributed an accurate method of measuring ice thickness by a special "short-pulse" type of radar.

In a three-year demonstration program, Coast Guard aircraft equipped with Side-Looking Airborne Radar (SLAR) flew over the Great Lakes three or four times a week. The SLAR, which can penetrate clouds, provided large area readings of the type and distribution of ice cover. The information was supplemented by short-pulse radar measurements of ice thickness. The radar data was relayed by a NOAA satellite to a ground station where NOAA analyzed it and created picture maps, such as the one shown at lower left, showing where icebreakers can cut paths easily or where shipping can move through thin ice without the aid of icebreakers. The ice charts were then relayed directly to the wheelhouses of ships operating on the Lakes.

NASA

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